A Thermographic Detection System for Pipeline Leaks

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Foreword

Since 1976 a number of projects have been initiated in Alberta by industry and by academic research institutions which are aimed at better utilization of our energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities have focused on coal, energy conservation and renewable energy and conventional energy resources. Administration for the program is provided by staff within the Scientific and Engineering Services and Research Division of Alberta Energy and Natural Resources.

In order to make research results available to industry and others who can use the information, highlights of studies are reported in a series of technology transfer booklets. For more information about other publications in the series, please refer to the inside back page.

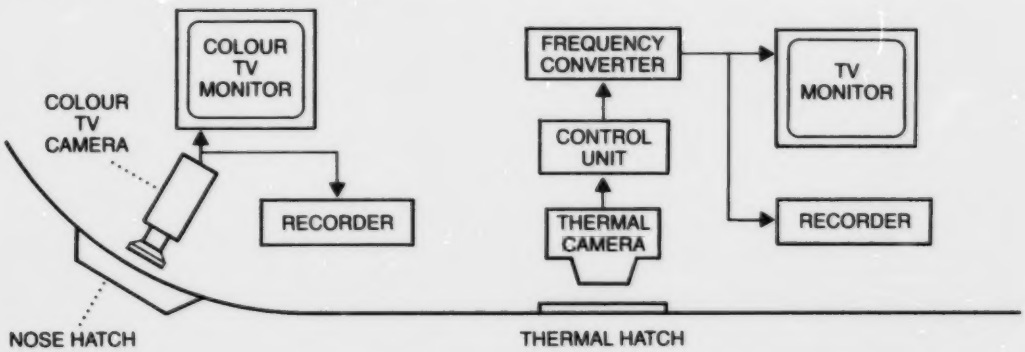
A Thermographic Detection System for Pipeline Leaks

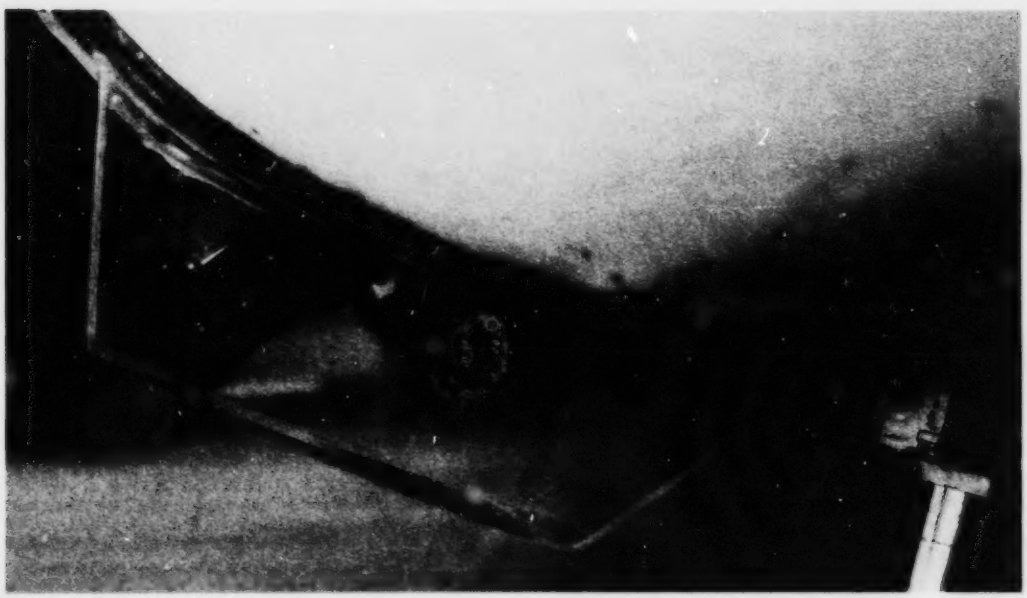
Leaks in natural gas pipelines are feared by transmission companies because they represent safety risks and lost revenues.

Despite the use of flow monitoring equipment within the pipeline system and surface or aerial patrols above buried pipelines, leaks still occur which sometimes go unnoticed until they reach a size where they are more difficult to repair and are significant safety hazards. Because present methods of detecting small leaks are either time-consuming, expensive or inefficient, a new inspection technique has been developed which may overcome the deficiencies of foot patrol and aerial observation methods.

The new technology uses an airborne thermography detection system which is capable of finding leaks that other techniques can miss. Also, it is faster and potentially less expensive than any of today's alternatives.

Block diagram of recording equipment.





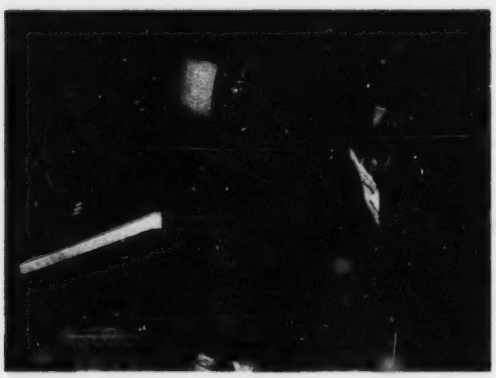
Video camera mounted inside a transparent housing forward of the nose wheel.

Feasibility Study

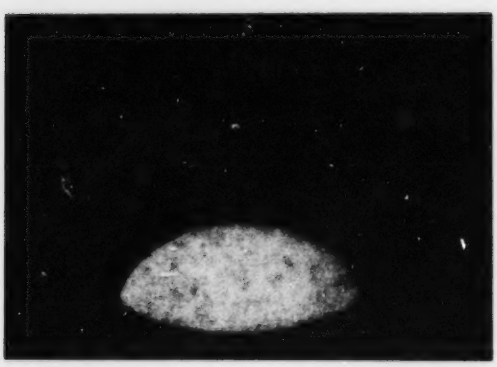
Based on an idea proposed to the A/CERRF Committee by Reconaissance Air Ltd. of Whitecourt, Alberta, funds were provided in 1984 to attach a thermographic camera and a videotape camera to the underbelly of a Cessna 206 single-engine aircraft.

Images produced by both cameras were recorded on videotape and were displayed on a monitor inside the aircraft where they could be viewed in flight. The use of a special high resolution lens allowed the aircraft to fly well above obstructions and still receive signals of adequate quality.

Because the thermographic detector is capable of distinguishing one object from another, on the basis of temperature differences, it was thought the technique would be ideally suited for finding "frost balls" above pipelines. These cold spots occur when natural gas escapes and freezes a small area of the surrounding soil cover.



Recording equipment on board the aircraft.



Hatch in floor through which the thermographic camera was aimed.

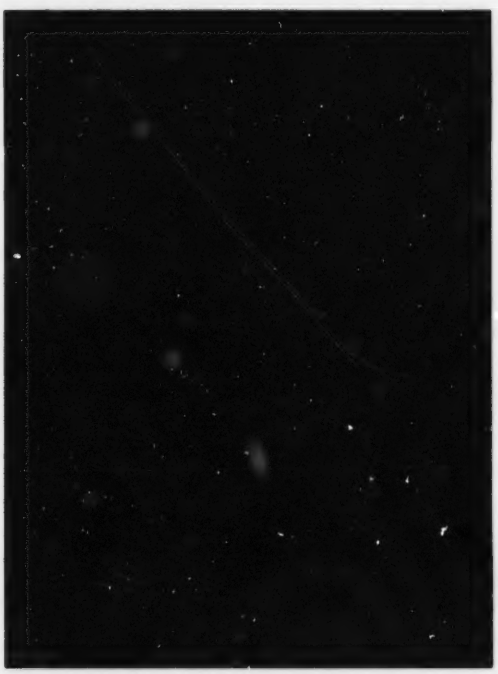
Test Results

In order to simulate "frost balls", several ice-bag targets were placed along a pipeline right-of-way during summer weather conditions. The smallest target, a single ice-bag, measured 8" x 12". The other targets were from two to four times the size of the single ice-bag.

At altitudes ranging from 500 feet to 1100 feet above ground level (A.G.L.) all four targets showed up as distinctive black spots on the recorder. When the aircraft was flown at 2000 feet A.G.L. the one-bag target was not detectable but the others were recorded.

The technique also detected a cold spot that was purposely created by pipeline company personnel to imitate the "frost ball" from a small leak. In this instance, the cold spot, which measured 14" x 18", represented the aftermath of a leak that is too small to be detected by conventional pipeline monitoring techniques.

Because of encouraging results from these studies, and in anticipation of providing an expanded service to industry, the original contractor merged with a helicopter-based surveillance company to form Aerial Recon Surveys of Whitecourt.



A small, simulated leak, meant to represent a "frost ball", is thermographically recorded as a dark spot relative to its surroundings.

A thermographic record of an ice-bag target.

Further Developments

Several oil and gas companies have sponsored additional investigations using a helicopter instead of a fixed-wing aircraft. This allowed slower flight speeds, which kept targets in sight for longer periods of time. Also, because the helicopter could be landed near a suspected leak, it offered the important advantage of an on-the-spot ground check, without the need for a return visit by pipeline personnel to confirm the presence of a leak.

Limitations

Crosswinds make it difficult to keep the aircraft aligned with pipeline rights-of-way but, so far, investigators have not established upper limits of crosswind speed above which overflights are impossible. Similarly, although precipitation is known to degrade the thermal signal, useful readings have been possible under a variety of weather conditions.

Costs

On a cost-per-mile basis, this service is competitive with present inspection methods. Depending on the length of pipeline to be overflown, costs are estimated to be approximately $15 to $35 per mile.

Other Applications

The thermographic detector is also capable of finding hot targets. At 500 feet and 800 feet A.G.L., it recorded groups of three or four ignited charcoal briquettes that were placed near the ground and surrounded by deciduous and coniferous forests.

Investigations have shown the technique can repeatedly distinguish between any two objects that differ in temperature by 2°C or more. Not only can it be used to find "frost balls" from gas leaks but it has been used to detect brine leaks and it shows promise for monitoring the movement of gas plumes and mapping forest fires.

A target of fresh water, purposely spilled in the snow, was meant to simulate a brine spill. Fresh snow had partially obscured the spill by the time it was overflown by an infra-red-equipped aircraft.

Although partially obscured by fresh snow, the outlines of a water spill were clearly visible on an infra-red scan from 600 feet above it.

Contacts

For further information, contact:

Eric R. Gould or John E. Wadlow
Aerial Recon Surveys
Box 1229
Whitecourt, Alberta
T0E 2L0

Telephone: (403) 778-3080

Additional copies of this publication are available from:

Alberta Energy and Natural Resources
Information Centre
Main FLoor, Bramalea Bldg.
9920 - 108 Street
Edmonton, Alberta
T5K 2M4

Telephone: (403) 427-3590

For more information about A/CERRF, contact:

Director, Energy Conservation and Renewable
Energy Research
Scientific and Engineering Services and Research Division
Alberta Energy and Natural Resources
2nd Floor Pacific Plaza
10909 Jasper Avenue
Edmonton, Alberta
T5J 3M8

Telephone: (403) 427-8042